28 Rec'd PCT/PTO 30 SEP 1998 09/101508

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7-30-99

PROGRAMMABLY TIMABLE PRIMING DEVICE

Background of the Invention

Field of the Invention

The present invention relates to the field of electrical firing mechanisms, and more particularly that of priming devices of an ignition detonator for miniature bombs, projectiles, missiles, and mines, having an electrical power supply and means for timing the action of a firing element of a primer.

Description of the Related Art

It is known to use priming devices having means for timing the action of a firing element of the primer.

~~Said timing~~ timing means are generally electronic, and failure thereof can result in premature action of the element on the primer, and thus in explosion of the weapon with which they are associated. It is self-evident that ~~said~~ the explosion can have serious consequences for the user or users.

To avoid this problem, French Patent ~~2-670-576~~ No. 2670576 describes a neutralization device ~~or~~ for weapons, having a housing, a pyrotechnic chain deactivated by mechanical safety means (in this instance a clock), and a timer which can be controlled by transmission means.

A device of this kind has a drawback, however, when it is desired to prime several neutralization devices simultaneously. The reason is that each of the timers must be programmed while taking into account the time used to program the previous ones. Such programming cannot therefore be other than imprecise, and leads to successive explosions because it does not allow for multiple simultaneous firings.

One of the purposes of the invention is to remedy these drawbacks by proposing a reliable electronic or electromechanical priming device, the timing system of which can be programmed simultaneously for multiple priming devices with the aim of achieving perfect synergy.

According to the invention, a priming device of a detonator therefore has an electrical power supply providing a first intensity to a circuit having means for timing the action of a

Summary of the Invention

firing element of a primer and to means capable of generating, upon expiration of the timing interval, a second intensity sufficient to actuate said element, the first intensity emerging from the power supply not being sufficient.

According to a particular feature, ~~said~~ the means are constituted by a capacitor, switching means, and means for controlling ~~said~~ the switching means allowing ~~said~~ the capacitor to be charged for a charging time (Tp2), then discharged, ~~said~~ the discharge causing the element to act on the primer.

According to another variant of the invention which allows numerous associated devices to be added, a priming device of a detonator has an electrical power supply[,] means for timing the action of a firing element of a primer, and means capable of generating, upon expiration of the timing interval, an intensity sufficient to actuate ~~said~~ the element, ~~said~~ the latter means having a capacitor, switching means, and means for controlling ~~said~~ the switching means allowing ~~said~~ the capacitor to be charged for a charging time, then discharged, ~~said~~ the discharge causing the element to act on the primer, the control means being constituted by a microcontroller.

In addition, the switching means ~~can be constituted~~ may comprise, for example, by transistors.

In order to improve the operating flexibility of the device, it is preferable for the timing means to have means for programming the timing interval; ~~said~~ the means can be entirely or partially integrated into the priming device. ~~Said means can~~ the means may comprise, for example, consist of code wheels or a microcomputer.

According to a particular feature, ~~said~~ the means ~~consist of~~ external means having an electrical power supply, a microcontroller, a display, two programming switches, and transfer means constituted by phototransistors.

According to another feature capable of preventing neutralization of the weapon by an unauthorized person, or of deliberately anticipating firing, a priming device according to the invention has booby-trap means which can consist of a circuit comprising switching means,

the opening of which causes the primer to fire.

Lastly, another object of the invention is a method for safing a priming device of a detonator, of the type having an electrical power supply and means for timing the action of a firing element of the primer, wherein the method consists, upon expiration of the timing interval, in charging a capacitor and then discharging it to cause firing.

Other advantages and features of the present invention will be apparent from the description of several variant embodiments with reference to the attached drawings, in which:

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Figure 1 depicts a simplified general diagram of the device according to the invention;

Figure 2 shows a diagram of the principal programming means;

Figure 3 depicts a variant embodiment of the invention;

Figure 4 shows a diagram of the external programming means according to a particular variant embodiment of the invention; and

Figure 5 shows a particular embodiment of the invention.

Figure 1 shows a diagram of the principal constituent means of a firing device of a primer of a detonator according to the invention. Said means are of the type having a housing within which are arranged electrical power supply means 10 for a circuit comprising principally a firing resistor 12 of primer 13, circuit closing means 20, and means 30 for timing firing after the circuit is closed.

Power supply means 10 are constituted by two lithium batteries supplying a voltage of 6 V.

In this variant embodiment, circuit closing means 20 are constituted by a mechanical bolt 21 having two positions, A and C, which is connected to a U-shaped key 22 placed in a constriction on the exterior of the housing, rotation of which allows the bolt to be placed in the desired position.

As shown in Figure 2, firing timing means 30 have means 32 for programming a timing interval, means 34 for switching the circuit which supplies power to priming resistor

12, and a capacitor 36 supplying an intensity I2 as it discharges, intensity I1 of the charging current of said capacitor being insufficient to cause firing of the primer.

In this first variant embodiment, programming means 32 comprises ~~are constituted by~~ code wheels 38 and a microcontroller 40. Said code wheels are luminescent, allowing programming both at night and during the day.

Microcontroller 40 controls the opening and/or closing of switching means 34.

As shown in Figure 3, said switching means 34 have first means 41 constituted by an electromechanical safety device 41 comprising a mechanical clock, associated with a mechanical changeover switch which is normally in the open position and which closes the circuit upon expiration of a predetermined operating interval of said clock.

They have second means constituted by a transistor 50 whose source is connected to power supply 10, its gate to microcontroller 40, and its drain to the input of the changeover switch of electromechanical assembly 41, and a transistor 55 whose source is connected to priming resistor 12, its gate to microcontroller 40, and its drain to the output of the changeover switch.

Third means are constituted by a timed-closure switch 65 arranged between electrical power supply 10 and microcontroller 40.

In addition, drain 53 of transistor 50 is connected to a short-circuit transistor 60 which is in turn connected to microcontroller 40 and to ground.

Moreover, resistors 70, 71, 72 limiting the current intensity are located in the circuit upstream from the electromechanical means and between the microcontroller and transistor 55, so that in the event the transistors and the electromechanical means fail, the current passing through priming resistor 12 is of an intensity insufficient to cause priming of the detonator.

Furthermore, signaling means 81 and 80 are arranged respectively downstream from timed-closure switch 65 and in parallel with priming resistor 12.

Lastly, means 35 constituted by elements 10 and 36 are capable of generating, upon expiration of the timing interval, an intensity I2 sufficient to actuate priming resistor 12, power supply 10 providing an intensity I1 capable of charging the capacitor and the latter supplying an intensity I2 when it discharges.

With this embodiment, in which the programming means are constituted by code wheels 38, when mechanical bolt 21 is in position A all the electronic means are grounded; while in position C, all the electronic means are powered, but capacitor 36 is not in any case connected to the power supply circuit until after a safety delay time generated by electromechanical safety device 41.

In a second variant embodiment, the programming means are constituted by an external programming device 100 and by information transfer means, by direct contact such as an RS232 connector, or of the transmission/reception type, for example using phototransistors. In this instance the circuit closing means are preferably constituted by a mechanical bolt 21 having three positions, A, B, and C: a position A in which all the electronic means are grounded; a position B in which capacitor 36 is grounded and power is supplied to the other electronic means; and a position C which follows position B and in which capacitor 36 is connected to the circuit after a safety delay time generated by electromechanical safety device 41.

External device 100 can be constituted by a microcomputer of the portable type into which a program is loaded, said program allowing the user to indicate, in particular, the firing time either in the form of a date, which then requires entry of the programming date if it does not already exist in the microcomputer, or in the form of a delay interval. After the user has confirmed the programming, the data are transferred via an RS232 connector to one or more priming devices simultaneously.

Said external device 100 can also be constituted by an assembly comprising an electrical power supply 110, a microcontroller 140, a display 145, two programming switches

146, 147, and a run/stop switch 112; and the transfer means comprise phototransistors 148, 149 associated with phototransistors arranged in the housing.

In this case, selection of parameters is accomplished via a preprogrammed drop-down menu. Data are displayed in blocks, and all the parameters associated with a block appear alongside one another, so that an overall view of the progress of each one is retained while programming the block.

There are four blocks, as follows:

DATE: corresponding to the programming date

DIRECT: the timing interval prior to priming of the detonator

CALENDAR: the date on which priming is to occur

TRANSMIT: validation of this block causes the programmed data to be transferred to the igniter.

As regards the two switches 146, 147, the function of one is to validate the data entry that is displayed and to display the first datum of the next parameter, which can be in the same block or the first one of the next block.

A booby-trap module 200, of the contact-opening type, is also added to the means described in the aforementioned first variant embodiment. Said module is constituted by a closed circuit, powered by power supply means described above, and comprising a certain number of contactors whose method of opening depends on the type of booby-trapping, which are connected to microcontroller 40. As an example, said contactors can be opened by remote control, or can be inertial, or can more simply be a tripwire resting on the ground in the vicinity of the igniter.

A device according to the invention, programming of which is accomplished by way of an external device 100, operates as follows:

The batteries are placed in the housing before it is used, and mechanical bolt 21 is in position A, means 20 and 30 thus not being supplied with electrical power.

The user then disengages key 22 from the constriction on the housing, then proceeds to turn the latter to position B in which capacitor 36 is grounded and power is applied to the other electronic means. The receiving circuit has two phototransistors 48, 49 located as close as possible to a portion of the housing which is transparent to the radiation emitted by phototransistors 148, 149 of device 100. The housing also has a notch which allows the respective phototransistors of programming means 100 and of the firing means to be positioned precisely opposite one another.

Once the run/stop switch has been closed, the microcontroller of assembly 100 causes a menu to drop down, displayed block by block on display 145, the transition to the next parameter of one block or to the next block being accomplished by actuating one of programming switches 146, 147, the other serving to validate the parameters and transmit them to the firing device.

The menu can, for example, have two blocks, one concerning the desired timing interval D1 in a day/hour/minute/second format, i.e. four parameters, and the other relating to the validation of said parameters and transmission of said parameters via phototransistors 148, 149, 48, 49.

When all the parameters have been validated, validation of the TRANSMIT block causes said parameters to be transferred from device 100 to the priming device. In return, microcontroller 40 sends back a copy of the parameters which is received by device 100, which verifies that they conform to those sent out previously, and issues a confirmation message releasing the transmission.

It is evident that when the priming time is selected in calendar mode, it is possible to transmit the same parameters, successively or simultaneously, to a plurality of priming devices, and thus to synchronize all the priming events.

The use of a microcomputer makes this synchronization operation even easier. All that is necessary is to connect the microcomputer to each of the RS232 connectors of the

various priming devices being synchronized, and then to transfer the parameters simultaneously to all said devices.

The firing means are then placed on a suitable explosive device. In the case of a mine, it can be placed on the target to be destroyed, by the user, who then proceeds to turn key 22 to position C and then withdraws it from the housing to prevent any access by an unauthorized person to bolt 21.

In this position, the countdown of the timing interval D1, which began when the transmission was released, continues, while the mechanical timing clock of the electromechanical safety means is triggered. Upon expiration of a preprogrammed operating time Tp1 of said clock, it causes mechanical changeover switch 41 to trip, and thus causes closure of the portion of the circuit located between transistor 50 and capacitor 36.

Thus, in all cases in which timing interval D1 programmed by the user is less than preprogrammed time Tp1, or in cases where microcontroller 40 or transistors 50, 55, 60 fail, firing cannot in any case take place until after said time Tp1 has elapsed.

After value D1 has counted down, microcontroller 40 deactivates short-circuit transistor 60 and activates transistor 50 which then becomes conductive. Capacitor 36 then charges, and after a preprogrammed time Tp2, called the capacitor charge time, has elapsed, microcontroller 40 activates transistor 55 which becomes conductive, thus allowing capacitor 36 to discharge through said transistor 55 and through priming resistor 12, the intensity I2 passing through the latter being sufficient to cause priming of the detonator.

Allowing the capacitor to charge only upon expiration of a timing period increases the reliability of the device, since no capacitor leakage current is present during that period.

Be it also noted that for safety reasons, it is preferable for capacitor charging time Tp2 to be long as compared with its discharge time. Any malfunctions which would be expressed as simultaneous actuations of all the transducers (such as EMP or nuclear effects) would thus have no consequences.

In addition, the process of charging the capacitor can of itself meet a need for nondegradable safety. The safety time is then just shorter than the time which results in a significant capacitor charge, i.e. one capable of causing firing of the primer when it discharges. It can be adjusted via the charging current. In this case an electromechanical safety device 41 is not necessary, whether capacitor charging is performed at power-up or before firing. In applications in which the safety time is very long and/or when the booby-trap module is used, however, utilization of electromechanical safety device 41 is required.

Especially when programming means 32 are constituted by coding wheels 38 and microcontroller 40, timed-closure switch 65 can be inserted into the circuit so as to generate an additional safety delay Tp3 before any firing when the user turns the key from position A to position C. In this variant embodiment, this delay is an operational safety delay: during this delay time, which is an integral part of interval D1, all the switching functions of transistors 50, 60, 55 of microcontroller 40 are inhibited.

Concurrently, the mechanical timing clock of electromagnetic safety means 41 is triggered. Upon expiration of a preprogrammed operating interval Tp1 for said clock, it causes the mechanical changeover switch associated with it to trip, thus causing closure of the portion of the circuit located between transistor 50 and capacitor 36.

Switch 65 and the clock thus constitute two simultaneously triggered safety elements of different types: one electrical, which acts on microcontroller 40; and the other mechanical, which acts on capacitor 36, such that priming of the detonator cannot occur prior to the higher value of times Tp1 and Tp3.

Another operating mode of the device described above consists in authorizing firing of primer 13 via booby-trap module 200 upon expiration of the longer of delays Tp1 and Tp3, specifically during the entire programmed timing interval; and, if applicable, in inhibiting transistors 50 and 55 when said timing interval elapses, thus rendering the device inert and recoverable. The reaction time between actuation of the booby-trap system and firing of the

primer is, in this case, equal to Tp2.

According to a variant embodiment of the invention, the timing means can be simplified as depicted in Figure 5. The priming device then comprises an electrical power supply 310 (batteries in this instance), a timed-opening relay 330, a timed-closure relay 335, a capacitor 336, and a priming resistor 12 of primer 13.

As soon as the batteries are inserted, the two relays are energized. Since relay 330 is initially closed, the capacitor charges. Said relay 330 opens after an interval Tp4, then relay 335 closes and capacitor 336 then discharges into resistor 12, causing firing of primer 13.

In the case of priming by displacement of a mechanical element, discharge of the capacitor supplies power to a solenoid, activation of which causes release of the electromechanical element which primes the detonator.

As far as the booby-trap means are concerned, accidental breakage of the tripwire, or opening of an inertial contactor when the priming device is moved, cause priming of the detonator. For safety reasons, however, priming cannot occur before the expiration of intrinsic safety time Tp1 and operational safety time Tp3, resulting from electromechanical means and/or timed switch 65.